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# Diagnoses of hybrid hummingbirds (Aves: Trochilidae). 7. Probable parentage of *Calliphlox iridescens* Gould, 1860

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*Abstract.*—*Calliphlox iridescens* Gould, 1860 is hypothesized to be a hybrid between *Calliphlox amethystina* and *Chlorostilbon aureoventris*. The hybrid, collected at Nova Friburgo, Rio de Janeiro, Brazil, exhibits a blended mosaic of plumage characters of the presumed parental species. External measurements of the hybrid fall between the character means of the parental species and approach the values expected from least squares regression of parental measurements.

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The miniature woodstar, *Calliphlox iridescens* Gould, 1860, was described from a unique specimen collected at Nova Friburgo, about 100 km northeast of Rio de Janeiro, Brazil. Gould (1860:310) observed.

> "If, as I believe, I am right in referring this little bird to the genus *Calliphlox*, it is one of the most remarkable Humming-birds that it has fallen to my lot to describe. In its size and form it is very similar to *C. amethystina*, but in colouring it is like a *Chlorostilbon*."

The singular appearance of the specimen prompted Gould (1861:plate 359) to make it the type of a new genus, *Smaragdochrysis*, which was adopted by Elliot (1878) and Salvin (1892). The taxonomic validity of *iridescens* was not questioned until Butler (1931:347) remarked in a brief note:

> "May I regard my belief that the little Hummingbird which Gould described (P.Z.S. 1860, p. 310) as *Calliphlox*? *iridescens* . . . is really a hybrid between *Calliphlox amethystina* (Gm.) and *Chlorostilbon* [*aureoventris*] *prasinus* (Less.)? . . . I have examined it repeatedly, and to my eye its external characters are entirely a mixture of those of these two species."

Subsequent authorities listed *Calliphlox iridescens* as a hybrid (e.g., Berlioz 1932, 1938; Peters 1945; Gray 1958; Wolters 1976) or omitted it altogether (e.g., Morony et al. 1975, Sibley & Monroe 1990). The taxonomic status of *C. iridescens* is still uncertain, however, because the accounts of Butler (1931) and Berlioz (1932, 1938) did not adequately review the morphological characters of the specimen in question and those of its putative parental species. In this paper, I confirm the hybrid origin of *Calliphlox iridescens* employing the methods outlined in Graves (1990) and Graves & Zusi (1990).

## Material and Methods

The type of *Calliphlox iridescens* (BMNH 1888.7.25.102 in The Natural History Museum, formerly British Museum of Natural History) appears to be an adult male in definitive plumage. This opinion is based upon the absence of striations on the maxillary ramphotheca (Ortiz-Crespo 1972), the presence of an iridescent gorget, and moderately elongated outer rectrices which lack terminal spots or markings.

I compared the specimen with series of all species in the subfamily Trochilinae, the typical hummingbirds (Zusi & Bentz 1982, Sibley & Monroe 1990, Bleiweiss et al. 1997), in the collection of The Natural History Museum. Color transparencies and videotape of the specimen were also compared with the collections of the National

Museum of Natural History, Smithsonian Institution. A second specimen of *Calliphlox iridescens*, reported by Ruschi (1951) and deposited in the Museu Nacional, Rio de Janeiro (M. N. 18275; "Brasil), was not examined. For the purposes of hybrid diagnosis (Graves 1990), I considered all hummingbirds (Trochilinae) that occur in the state of Rio de Janeiro as potential parental species (Appendix 1).

Measurements of wing chord, bill length (from anterior extension of feathers), and rectrix length (from point of insertion of the central rectrices to the tip of each rectrix) were taken with digital calipers and rounded to the nearest 0.1 mm (Table 1). Color descriptions were made under natural light.

I considered four alternatives—the specimen represents an unrecognized color morph of a species listed in Appendix 1, a chemically-altered artifact, a hybrid, or a valid species. Because *Calliphlox iridescens* differs significantly in size and shape from all species in the subfamily Trochilinae, it does not represent a previously undiscovered color morph or chemically-altered artifact. As hybrids have no standing in zoological nomenclature, the burden of proof rests on the systematist to refute the possibility of hybridization before bestowing species status on a unique specimen. I was unable to reject the hypothesis of hybridity and thus refer to the specimen as a hybrid in the remainder of the paper.

The diagnosis was approached hierarchically. The pool of potential parental species (a maximum of $\binom{27}{2} = 351$ pairwise combinations, Appendix 1) was narrowed by the comparative analysis of plumage and soft part colors and feather shape. The restrictive hypothesis then was tested with an analysis of size and external proportions. In previous papers I used bivariate plots of mensural characters and least squares regression lines (Wilkinson 1989) projected through parental measurements to illustrate the relationship of hybrids to their hypothesized parental species (e.g., Graves & Newfield 1996, Graves 1998a, 1998b).

Table 1.—Ranges and means (± one standard deviation) of measurements (mm) of representative specimens (adult male) of *Chlorostilbon aureoventris*, *Calliphlox amethystina*, and their probable hybrid, *C. aureoventris* × *C. amethystina* (=*Calliphlox iridescens* Gould, 1860; BMNH 1888.7.25.102). Measurements of male *Chlorestes notatus* are included for comparison.

| | *aureoventris* ($n$ = 12–14[a]) | *amethystina* ($n$ = 10–11[b]) | *notatus* ($n$ = 11[c]) | Hybrid BMNH 1888.7.25.102 |
|---|---|---|---|---|
| Wing chord | 43.3–50.7 (46.6 ± 2.3) | 30.4–33.1 (32.0 ± 0.9) | 47.3–50.5 (48.8 ± 1.1) | 39.1 |
| Bill length | 13.4–17.2 (14.9 ± 1.2) | 11.4–13.6 (12.5 ± 0.8) | 14.9–16.8 (15.8 ± 0.7) | 14.2 |
| Rectrix 1 (R1) | 18.6–23.7 (21.2 ± 1.8) | 13.3–15.1 (14.2 ± 0.6) | 27.3–30.1 (28.8 ± 1.0) | 17.3 |
| Rectrix 2 (R2) | 20.4–25.0 (22.5 ± 1.8) | 16.1–17.4 (16.9 ± 0.5) | 27.5–31.3 (29.4 ± 1.0) | 21.0 |
| Rectrix 3 (R3) | 22.1–27.3 (24.4 ± 2.0) | 20.8–25.0 (23.0 ± 1.1) | 26.9–31.4 (29.2 ± 1.2) | 23.9 |
| Rectrix 4 (R4) | 24.5–30.4 (27.0 ± 1.9) | 28.0–31.1 (29.7 ± 0.9) | 26.2–31.2 (28.6 ± 1.3) | 28.6 |
| Rectrix 5 (R5) | 26.3–32.7 (28.8 ± 2.0) | 32.2–36.9 (33.8 ± 1.4) | 25.6–29.5 (27.3 ± 1.1) | 30.3[d] |

[a] Bahia ($n$ = 8); Rio de Janeiro ($n$ = 3); São Paulo ($n$ = 3).
[b] Bahia ($n$ = 1); "Brazil" ($n$ = 3); Minas Gerais ($n$ = 3); Rio de Janeiro ($n$ = 4).
[c] Bahia ($n$ = 2); "British Guiana" ($n$ = 1); Pará ($n$ = 8).
[d] Rectrix tip frayed.

Fig. 1. Ventral and dorsal views of adult male *Chlorostilbon aureoventris* (top), *Calliphlox amethystina* (bottom), and their putative hybrid, *C. aureoventris* × *C. amethystina*, (=*Calliphlox iridescens* Gould, 1860; BMNH 1888.7.25.102).

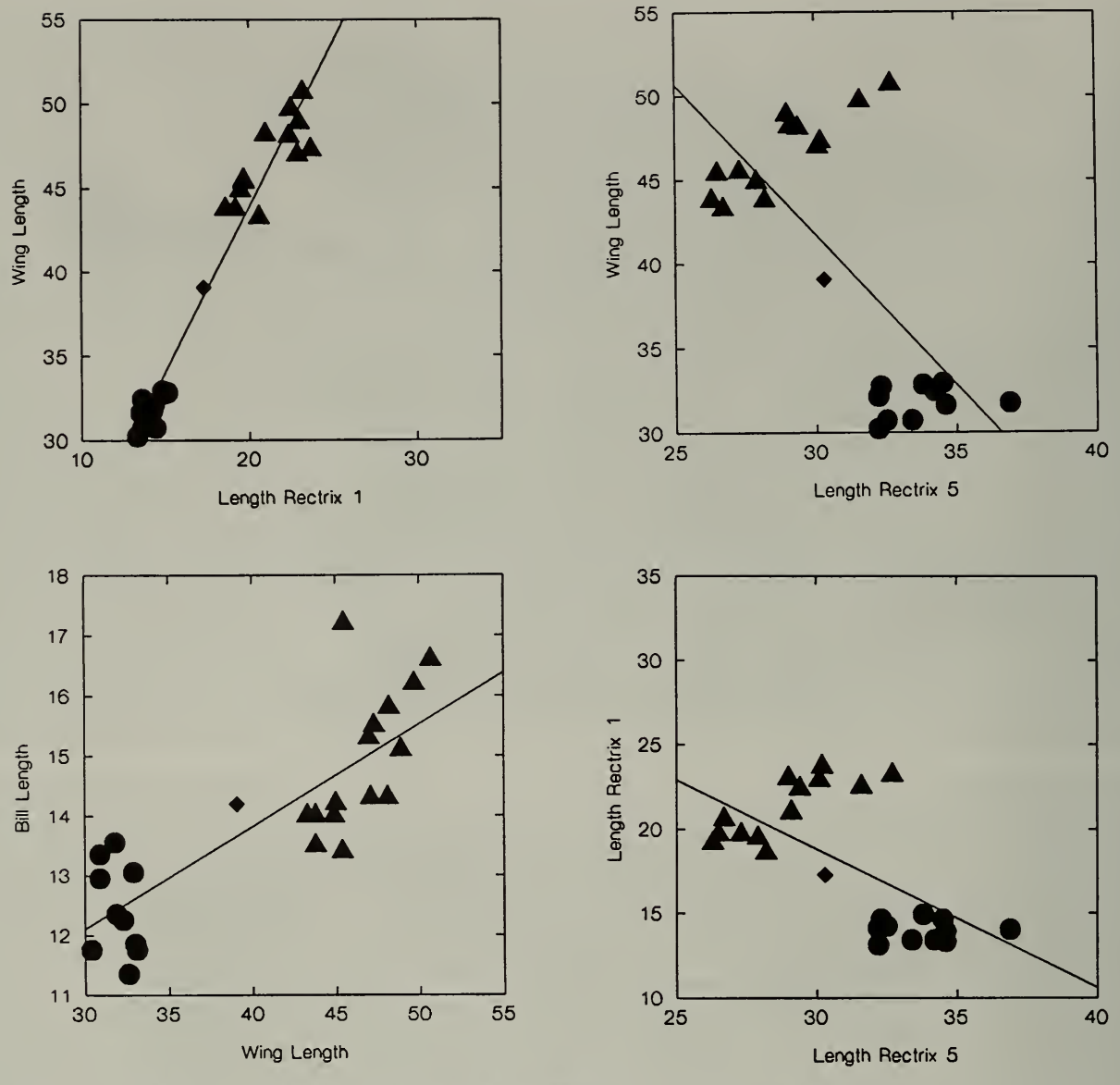


Fig. 2. Bivariate plots of selected measurements (see Table 1) of adult male *Chlorostilbon aureoventris* (▲), *Calliphlox amethystina* (●), and their putative hybrid (♦), *C. aureoventris* × *C. amethystina*, (=*Calliphlox iridescens* Gould, 1860; BMNH 1888.7.25.102). Least squares regression lines are illustrated for comparison.

Table 2.—The percent difference between measurements (mm) of the hybrid (=*Calliphlox iridescens* Gould, 1860; BMNH 1888.7.25.102) and the mensural midpoints (average of character means from Table 1) of species combinations.

| | *Chlorestes notatus* & *Calliphlox amethystina* | Hybrid | *Chlorostilbon aureoventris* & *Calliphlox amethystina* | Hybrid |
|---|---|---|---|---|
| | Parental Midpoint | Percent Difference | Parental Midpoint | Percent Difference |
| Wing chord | 40.4 | 3.2 | 39.3 | 0.4 |
| Bill Length | 14.4 | 0.5 | 13.7 | 3.8 |
| R1 | 21.5 | 24.0 | 17.7 | 2.3 |
| R2 | 23.2 | 10.2 | 19.7 | 6.7 |
| R3 | 26.1 | 9.2 | 23.7 | 0.9 |
| R4 | 29.2 | 2.0 | 28.3 | 1.0 |
| R5 | 30.5 | 0.8 | 31.3 | 3.3 |

Close proximity of hybrids and regression lines (for all pairwise combinations of variables) was interpreted as evidence consistent with the specified hybrid hypothesis, assuming polygenic inheritance of external morphology. Concordance of results from plumage and size analyses is regarded as strong support for the hypothesis (Graves 1990, Graves & Zusi 1990).

## Results and Discussion

*Plumage characters.*—The hybrid possesses several characters that facilitate the identification of its parental species: (a) brilliant silvery-green gorget; (b) moderately forked tail (fork depth = 43% of tail length); and (c) mandibular ramphotheca yellowish-brown (Fig. 1). Perhaps as informative, the hybrid *lacks* several conspicuous traits that are present among source pool species (Appendix 1): (a) contrasting rump band; (b) brilliant frontlet or coronal patch; (c) rufous or chestnut pigmentation on rectrices; (d) pronounced blue or violet iridescence on body plumage; (e) white rectricial spots; (f) white bases or margins of gorget feathers; (g) thickened primary rachises; and (h) racket-tipped or attenuated rectrix tips.

This association of characters can be derived from only two of the possible pairwise combinations of species (Appendix 1): *Chlorestes notatus* × *Calliphlox amethystina* and *Chlorostilbon aureoventris* × *Calliphlox amethystina*. Other combinations of species can be eliminated from consideration because they either lack characters exhibited by the hybrid, or possess one or more distinctive characters that are not expressed, even subtly, in the hybrid. The geographic ranges of *C. aureoventris* and *C. amethystina* overlap extensively in Brazil, and both are found in the vicinity of Nova Friburgo. *C. notatus* appears to reach its southern limit on the Atlantic coastal plain near the city of Rio de Janeiro and is not known to occur in the uplands near Nova Friburgo. However, 19th century collections of birds from Nova Friburgo often contained species from nearby lowlands (fide J. F. Pacheco, pers. comm.). *C. notatus* and *C. aureoventris* are similar in size and plumage color, differing most noticeably in tail shape—square or slightly rounded in *C. notatus*, shallowly forked in *C. aureoventris* (Table 1).

*External measurements.*—I evaluated the two parental hypotheses by inspecting raw data, bivariate plots, and least squares regressions of measurements. Measurements of the hybrid fell within the character means of both possible parental combinations, *Chlorestes notatus* × *Calliphlox amethystina* and *Chlorostilbon aureoventris* × *Calliphlox amethystina*. External measurements of the hybrid most closely approximate the values expected from least squares regression of measurements of *Chlorostilbon aureoventris* × *Calliphlox amethystina* (Fig. 2, Appendix 2). Hybrid characters differ from the parental midpoints (average of parental character means, Table 2) of *C. aureoventris* × *C. amethystina* by 0.4–6.7%, and from *C. notatus* × *C. amethystina* by 0.5–24%. Measurements of the hybrid are closer to the parental midpoint of *C. aureoventris* × *C. amethystina* for 5 of the 7 characters.

In summary, both plumage and external morphology are consistent with the hypothesis that *Calliphlox iridescens* represents a hybrid between *Chlorostilbon aureoventris* and *Calliphlox amethystina*. For taxonomic purposes, *Calliphlox iridescens* Gould is available only for the purpose of homonymy.

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## Appendix 1

Species of trochiline hummingbirds that occur in the state of Rio de Janeiro, Brazil (fide J. F. Pacheco, pers. comm.). Vagrant species (less than three records in Rio de Janeiro) are marked by an asterisk. Parentheses enclose a representative list of characters or traits that would probably be expressed in hybrid progeny of these species, but that do not occur in *Calliphlox iridescens* Gould, 1860 (BMNH 1888.7.25.102). Taxonomy follows Sibley & Monroe (1990): *Eupetomena macroura* (violet-blue head and breast, thickened primary rachises); *Melanotrochilus fuscus* (black body plumage, white outer rectrices); *Colibri serrirostris* (purple auricular tufts, subterminal band on rectrices); *Anthracothorax nigricollis* (black ventral plumage, rufous pigmentation on rectrices); **Chrysolampis mosquitus* (brilliant coronal patch, rufous pigmentation on rectrices); *Stephanoxis lalandi* (brilliant coronal patch, elongated crest plumes, blue ventral plumage); *Lophornis magnificus* (rufous crest, contrasting rump band); *Lophornis chalybeus* (white-tipped gorget feathers, contrasting rump band); *Popelairia langsdorffi* (contrasting rump band, attenuated rectrices); **Discosura longicauda* (contrasting rump band, racket-tipped rectrices), *Chlorestes notatus*, *Chlorostilbon*

*aureoventris*, **Thalurania furcata* (violet breast and belly); *Thalurania glaucopis* (brilliant coronal patch), *Hylocharis sapphirina* (rufous chin and rectrices, violet head and breast); *Hylocharis cyanus* (white chin, violet head and upper breast); **Hylocharis chrysura* (cinnamomeus chin, golden-bronze tail); *Leucochloris albicollis* (white throat, white-tipped rectrices); *Polytmus guainumbi* (white-tipped rectrices); *Amazilia versicolor* (white throat, dark subterminal band on outer rectrices); *Amazilia fimbriata* (white-margined throat feathers); *Amazilia lactea* (violet-blue throat and upper breast); *Aphantochroa cirrochloris* (dull plumage, large size); *Clytolaema rubricauda* (rufous rectrices); *Heliothryx aurita* (brilliant coronal patch, white outer rectrices); *Heliomaster squamosus* (brilliant coronal patch, white malar mark, white medial stripe from upper breast to vent); *Calliphlox amethystina*.

## Appendix 2

General comparative description of definitive plumages of male *Chlorostilbon aureoventris*, *Calliphlox amethystina*, and the hybrid, *C. aureoventris* × *C. amethystina* (=*Calliphlox iridescens* Gould, 1860; BMNH 1888.7.25.102). Descriptions of structural colors are unusually subjective, as color seen by the observer varies according to the angle of inspection and direction of light. For this reason I use general color descriptions.

The dorsal plumage in *amethystina*, from crown to uppertail coverts, is weakly iridescent and dull green to pale bronzy-green in coloration; the iridescence is brighter from a "tail-on" view, as opposed to a "head-on" view. The crown is dull dark green viewed head-on. The dorsum of *aureoventris* is significantly more iridescent than that of *amethystina*, appearing golden-green to bluish-green, depending on the angle of observation. The crown is brilliant golden-green, viewed head-on, with coppery reflections on the periphery.

The quality and brightness of dorsal iridescence in *iridescens* is intermediate to those of the parental species, but closer in overall appearance to *amethystina*. The crown reflects a pale, but variable, bluish-green iridescence when viewed head-on.

The brilliant rosy-red to purplish-red gorget of *amethystina*, which extends from the chin laterally to the eye and posterior to the upper throat, is bordered posteriorly by a white or grayish-white pectoral band that blends posteriorly into dull green on the sides. Gorget feathers are of moderate length (6.1–7.0 mm), medium gray basally bordered distally by a narrow transitional band of gray glossed with green and tipped with a rosy-red terminal disk (from posterior margin of gorget: 2.1–2.4 mm deep, 1.7–2.9 mm wide). Feathers of the lower breast, sides, and flanks are dark gray basally, tipped subterminally with a weakly-iridescent green disk, and fringed (heavily along the midline) with grayish-buff or buff. Vent feathers are white. Tibial plumes, which extend past the base of the hallux, are dark gray, broadly tipped with buffy-white. Undertail coverts are grayish-buff fading to white or pale buffy-white at the margins (subterminally glossed with green in some individuals).

With the exception of white vent plumes, the ventral plumage of *aureoventris* exhibits brilliant iridescence when viewed head-on. Although there is considerable color variation among individuals, iridescence is predominately bluish-green on the throat, upper breast, and undertail coverts, tending toward golden-green on the lower breast, sides and belly. Throat feathers are medium gray basally, becoming dark gray distally, and abruptly tipped with a bluish-green disk (from lower throat, 1.6–2.0 mm deep, 3.0–3.3 mm wide). Gorget feathers (5.1–5.8 mm) are relatively shorter than in *amethystina*. Tibial feathers are dark gray and reach but do not exceed the base of the hallux.

The gorget of *iridescens*, similar in shape to that of *amethystina*, exhibits a peculiar pattern of iridescence, predominately pale silvery-green viewed head-on, but irregularly marked with a coppery hue, especially on the sides of the throat. Closer inspection reveals this is due to coppery or bronze iridescence emanating from barb tips of otherwise silvery-green disks (or silvery-blue in certain lights). Lateral gorget feathers (5.9–6.0 mm long) are dark gray basally, broadly tipped with a silvery-green disk (2.1–2.2 mm deep, 2.7–2.8 mm wide). The depth (usually <1.0 mm) and intensity of coppery disk margins increase laterally, a few gorget feathers lacking coppery iridescence are juxtaposed among margined feathers in the center of the throat. The breast and sides of *iridescens* are dark green (dark gray with only a hint of green iridescence viewed head-on); feather bases are dark gray and grayish feather margins are largely restricted to the lower midline above the vent. Evidence of the white pectoral band of *amethystina* is limited in *iridescens* to a scattering of white and pale gray basal feather barbs. Tibial plumes, which are dark brownish-gray lightly tipped pale buffy-gray, are intermediate in length between those of *amethystina* and *aureoventris*, narrowly passing the base of the hallux. Undertail coverts are buffy gray with a weakly-defined subterminal green spot of variable size and extensively margined with pale buffy-gray.

The tail of *amethystina* is moderately forked. The outer rectrices (R2–R5) are narrow (3.3–3.6 mm wide) and dull purplish-black in coloration. The outer vane is faintly (R3) or moderately (R2) glossed with green. R3–R5 are faintly tipped with green in some individuals (unstriated ramphotheca). Both vanes of R1 are extensively glossed with dark green. Rachises are dark brown on both surfaces. The shallowly forked tail of *aureoventris*, which is shining steel-blue on both surfaces, contrasts highly with the brilliant bluish-green tail coverts. Outer rectrices are 5.4–6.8 mm wide.

The color and shape of the hybrid's tail are inter-

mediate between those of *amethystina* and *aureoventris*. The right outer rectrix (R5) is 4.0 mm wide. The outer vane of R2 and both vanes of R1 are glossed with green.

Remiges of *amethystina* are dark purplish-brown, whereas those of *aureoventris* are bluish-black and significantly glossier. Neither species shows unusual notching or emargination of the primaries and secondaries. The remiges of the hybrid are intermediate in color between those of the hypothesized parental species.

The maxillary ramphotheca in *amethystina* is black, the mandibular ramphotheca is brownish-black distally, medium brown at the base of the bill. Feathering on the maxillary ramphotheca extends to the anterior edge of the nasal operculum but does not obscure it. The mandibular ramphotheca and the proximal ⅔ of the maxillary ramphotheca of *aureoventris* is light yellowish-brown (red in life). Feathering does not reach the anterior edge of the nasal operculum, which is fully exposed. The bill of the hybrid is almost perfectly intermediate in color. The maxillary ramphotheca is dark brown proximally becoming black distally. The mandibular ramphotheca is pale yellowish-brown, gradually darkening to brownish-black on the distal fifth. Feathering extends to the anterior edge of the nasal operculum, which is slightly inflated.